Comments Concerning NHTSA's Investigation of Increasing Fuel Economy Standards for Model Years 2005-2010

Docket No. NHTSA-2002-11419

Submitted on behalf of:

Union of Concerned Scientists

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Comment Summary

Thank you for this opportunity to comment on NHTSA's investigation of increasing fuel economy standards for Model Years 2005-2010. In light of increasing consumer costs, growing national oil dependence, and rising negative environmental impacts of driving, we recommend that the agency begin raising fuel economy standards for light trucks at a rate of 1 to 2 miles per gallon per year beginning with Model Year 2005. In addition, we recommend that NHTSA pursue an increase in passenger car fuel economy standards of 1.5 to 2.5 miles per gallon at the same time. Finally, in accordance with the stated safety concerns in the request for comments, we recommend that NHTSA begin a concurrent process to develop safety standards to reduce 1) the existing safety risks to SUV and other light truck drivers due to their high risk of driver fatality from rollovers and 2) the risks imposed on others by heavier/taller vehicles on the road.

The specific requests of the docket have been grouped into the following five sections:

1. Technology: By Model Year 2010, our technology analysis indicates that light trucks could average 27 to 28 mpg using conventional technology that will have been in production for 6 to 10 years by at least one manufacturer. Incorporating the Integrated Starter Generator technology, expected to go into production within the next few years, light trucks could average 32 to 33 mpg by 2010. In addition, sales of hybrid electric light trucks that will begin entering the market by 2004 could contribute to even larger fuel economy improvements. Fuel cell vehicles, however, are unlikely to play any significant role in the improvement of light truck fuel economy in this timeframe.

2. Safety: Safety is primarily a function of design and size, not weight. The most recent evidence on the relationship between vehicle safety and weight from Dynamic Research, Inc. indicates that there is no statistically significant correlation between reducing the weight of every vehicle in the passenger automobile and light truck fleet and the safety of drivers in that fleet. The safety role of weight is associated with its distribution, an unequal distribution of weight increases fatalities – past evidence from NHTSA, recently further supported by Dynamic Research, Inc., indicates that reducing the weight of light trucks will improve overall safety on the highways. Further, recent analysis by Ross and Wenzel indicate that design is the dominant factor in vehicle safety, as evidenced by the Volkswagen Jetta and Honda having equal or better safety records than the average SUV. Thus, the key factors NHTSA should consider with respect to safety are the design aspects of SUVs and other light trucks that lead to driver deaths in rollovers and the design and weight aspects of SUVs and other light trucks that lead to fatalities in other vehicles. Safety concerns and the need to improve fuel economy are not in conflict and NHTSA can and should proceed on improving both fronts.

3. Regulation Timeline: The 2005-2010 timeline provides additional regulatory certainty for automakers in developing their production plans. Rather than the past 1 year regulatory cycle, the longer timeline would enable automakers to shift their planning more towards fuel economy instead of power and size, thus enabling higher targets to be met. This timeline, however, would be compromised if minimal fuel economy targets are set and the ability of the automakers to take advantage of the enhanced certainty is not taken advantage of.

Within this timeline, the 2005 standard for light trucks can be set to at least 22 mpg. The commitment Ford has made and GM has said will beat, represents a approximately a 7% increase in their light truck fuel economy by 2005 – 22 mpg represents a 6.3% increase, thus not even holding the industry to the precedent set by Ford. By 2008 at the latest, we recommend setting light truck fuel economy to 27.5 mpg, to bring light trucks up to current car standards. By 2010, we recommend a light truck standard of at least 30 mpg and as high as 33 mpg, with the 30 mpg level being achievable with NAS path 2 technologies and the 33 mpg being achievable with the additional application of safety-enhancing weight reductions.

4. Benefits: Our analysis indicates that bringing light trucks to the fuel economy level of today's cars will save at least one million barrels of oil per day by 2020 if phased in over the NHTSA timeline. Reaching an average light truck fuel economy of 32.6 mpg by using existing technology along with Integrated Starter Generators over the NHTSA timeline would result in saving 1 million barrels of oil per day by 2014 and over 1.7 million barrels of oil per day by 2020. This translates into greenhouse gas savings of about 50 to 80 million metric tons of carbon equivalent per year. The latter case represents a reduction in oil consumption and global warming emissions from passenger cars and light trucks of 10% in 2014 and 15% in 2020. Finally, consumers would be saving between $1,200 and $2,200 over the life of their vehicle – this indicates that in the cost benefit analysis there is actually a net savings achieved in providing the oil use and global warming gas emissions reductions. This savings and the investments made by automakers will create new jobs both in the domestic auto industry and throughout the US economy.

5. The National Academy of Sciences CAFE study: Overall, the NAS study did a good job evaluating the technical potential of engine and transmission technologies to increase car and light truck fuel economy. The study did not, however, provide an adequate assessment of the role of weight reduction and aerodynamic/rolling resistance improvements in increasing vehicle fuel economy. Further, the NAS study did not account for synergistic effects within technology packages. The combined effect is an under-estimate of the potential fuel economy improvements. Overall, if the role of weight reduction is ignored, our results and those of the NAS panel are similar.

   On the safety question, the NAS panel was not able to come to a consensus, and in fact, the position of the minority of the panel has been supported by the more recent safety analysis noted above. Since the NAS safety analysis was performed based on out-of-date information and makes some erroneous assertions in using that date for projections, it should not be relied upon in NHTSA's deliberations.

   NHTSA is also advised to be cautious in using the "Cost-Efficient" analysis in the NAS report. While this analysis is performed correctly, it is important to be clear what it represents, it shows the choice a rational consumer would make in order to MAXIMIZE their private benefit from investing in fuel economy. The government's role, however, is to maximize the benefit to society which indicates the need to include external factors as well as to use a social discount rate analysis rather than a credit-card rate analysis as was performed by the NAS panel. Given the timeframe being considered by NHTSA, it therefore seems more appropriate to focus on the Path 2 technology case from Chapter 3 of the study. The model results from this path, when combined with year 2000 sales fractions, results in a light truck fleet that achieves 30 miles per gallon. Using NAS cost estimates and a social discount rate of 5%, this leads to a net benefit to consumers of over $1,300.

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In summary, it seems clear that NHTSA can significantly increase the fuel economy of light trucks over the 2005-2010 timeframe. The technology exists to increase the fuel economy of both light trucks and passenger cars, and putting this technology into vehicles will provide significant benefits for the nation and the environment while saving consumers money and creating jobs in the US automobile industry and all other sectors of the economy. The question of safety need not hinder progress on fuel economy as the weight issue has historically mislead the fuel economy debate due to inadequate inclusion of modern data or assessment of the role of design and size in the safety analysis.

We would welcome NHTSA's interest in pursuing these levels of fuel economy and safety improvements and offer our assistance in this matter.

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What follows are more detailed discussions or information sources regarding the above five areas.

1. Technology

The following are excerpts from a paper to be published by the Society of Automotive Engineers in June, 2002. The paper, number 2002-01-1900, is titled: Near-Term Fuel Economy Potential for Light-Duty Trucks, and is authored by: Feng An, Consultant ; David Friedman, Union of Concerned Scientists; Marc Ross, University of Michigan. The paper covers technology packages that could be used within the 2005-2010 timeframe to improve light truck fuel economy. All of the technologies considered, with the exception of belt driven or integrated starter generators, are either already on production vehicles or have been announced for production vehicles within the next two Model Years. The analysis did not include the role that hybrid electric vehicles could play in improving light truck fuel economy – in general, with vehicles such as the hybrid Ford Escape SUV, expected late in 2003, that can achieve 40 mpg, it can be assumed that hybrids represent a factor that reduces the risk of achieving any specific level of improvement that can be made with conventional technology by Model Year 2010. Beyond Model Year 2010, hybrids are likely to have a larger share of the new vehicle market and will have to be explicitly considered in fuel economy evaluation.

Other analysis from UCS on light truck and passenger vehicle fuel economy technology is available as follows:

Drilling in Detroit: Tapping Automaker Ingenuity to Build Save and Efficient Automobiles; available at <http://www.ucsusa.org/vehicles/drill_detroit-exec.html>.

Greener SUVs: A Blueprint for Cleaner, More Efficient Light Trucks; available at < http://www.ucsusa.org/vehicles/greener.SUVs.html>.

TECHNOLOGIES CONSIDERED

POWERTRAIN EFFICIENCY

High Specific Power and Low Friction

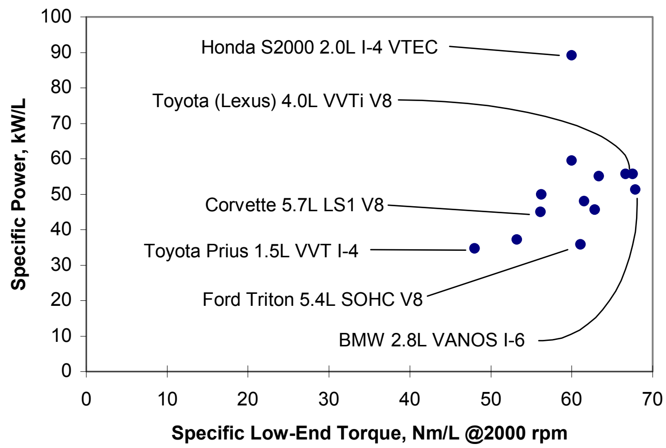
Much of the efficiency improvement over the last two decades resulted indirectly from increasing engine specific power. This achievement enabled a 58% engine displacement downsizing and a 26% reduction in average 0-to-60 mph acceleration time [2]. Engine downsizing implies additional benefits through reduced engine friction and weight. Specific power was increased by adding valves, fuel injection, improved controls, low-friction and lightweight materials, higher engine speed, application of numerical analysis techniques to optimize engine processes, precision manufacturing, and greatly improved quality control.

The average specific power of all model year 2000 cars and light trucks was 43 kW/L. The 115 hp, 1.6L engine used in a Honda Civic HX has a specific output of 54 kW/L. In addition to 4-valves per cylinder, this engine has variable valve control (VVC, Honda's "VTEC" design), aluminum block and heads, and numerous refinements that cut friction and improve the efficiency of induction and exhaust processes. The VTEC-E engine also uses lean operation under low-power driving. While this feature contributes improved engine efficiency under low power driving, it doesn't contribute to improved specific power. The VTEC engine used by the MY2001 Civic EX has higher specific power – 56 kW/L, and no lean-operation. One striking element of using the VTEC-E engine is that the vehicle tailpipe emissions are not compromised, instead, the ULEV emission levels are achieved by using an unique NOx storage catalyst technology. Another key aspect of recent improvements, aided by increasing use of electronic monitoring and control of engine process, is individual cylinder control of air/fuel mixtures. Such refinements and others are being deployed by all automakers.

The opportunity to continue increasing specific power is excellent. Figure 1 shows specific power (in kW/L) and torque specs for some leading-edge contemporary engines. Ford's new Duratec HE engine series is another example, with the just-introduced 2.3L version for the Ranger pickup that provides 135 hp, for a specific output of 50 kW/L, compared to the 36 kW/L of the 2.5L 119 hp engine it replaces [15].

Examples also include BMW's variable-valve controlled ("VANOS") engines at over 50 kW/L, Nissan's non-VVC Sentra 1.8L and Maxima 3.0L engines at 52 and 56 kW/L, the Toyota Corolla and Echo VVTi engines at 51 and 54 kW/L, respectively, among others. GM's new Vortec 4200 inline six, producing 270 hp with 4.2L as announced for use in MY2002 SUVs such as the Chevy Trailblazer, features an aluminum block, DOHC, 4-valve per cylinder, and a VVC design for adjusting the cam phasing of the exhaust valves; the result is specific output of 48 kW/L, compared to the typically 40-42 kW/L output of current GM truck V8 engines which the new inline six could potentially replace [16].

Figure 1. Specific Power and Torque of Selected Gasoline Engines



Source: Selections from *Ward's Auto World,* "10 Best Engines" 1999-2001

For comparison purpose, Table 2 lists more detailed characteristics of three baseline engines and the Civic VTEC-E engine. The specific power of the VTEC-E engine is 54% higher than the Caravan engine, 38% higher than the Explorer engine, and 28% higher than the Silverado engine. The specific torque of VTEC-E engine is also higher than that of the other engines: 3% higher than the Caravan, 8% higher than the Explorer, and 10% higher than the Silverado. Finally, compared to the baseline engines, the VTEC-E engine also has higher maximum engine speed of 6300 RPM.

Table 2. Characteristics of Three Baseline Engines and VTEC-E Engine

	Silverado 1500 2WD	*Grand Caravan AWD*	*Explorer Standard V6*	*Civic VTEC-E Engine*
Engine	V-8	V-6	V6	I-4
Disp. (L)	4.8	3.8	4.0	1.6
Max power (hp)	270	180	210	115
Rpm @ max hp	5200	4400	5250	6300
Max tor. (lb.ft)	285	240	240	104
rpm @ max tor.	4000	3200	3250	5400
kW/L	42	35	39	54
Gap vs. VTEC-E	28%	54%	38%	0%
lb.ft/L	59	63	60	65
Gap vs. VTEC-E	10%	3%	8%	0%

As specific power and specific torque are increased, the engine needs to be downsized to maintain vehicle performance. Engine downsizing based on specific power alone tends to reduce torque, or the maximum power attainable without changing engine speed. Instead, we downsize Caravan and Explorer engines based on fixed 0-60 mph acceleration time as a standard benchmark for vehicle performance. If added torque is needed for the Caravan or the Explorer, sophisticated transmission controls can be used so that when high power is required, high engine speed is quickly available under tight control. A possible consequence of using a high-speed high-specific-power engine is increased shift-busyness of transmission and engine speed. Using a

CVT or 6-gear transmission, which will be addressed in the next section, can largely solve this problem. The best solution may be to combine the downsized engine with an on-shaft ISG that can provide launch assist to boost torque at low engine speed. This will also be discussed in the later section.

While the VTEC-E engine would provide higher efficiency and enable engine downsizing for the Silverado, its base engine is preserved with the addition of cylinder cut-off. This was done because it represents a more cost-effective solution for the 8-cylinder engine. Cylinder cut-off, also known as "variable-displacement," or "displacement-on-demand" technology, shuts-down part of the engine during low-power demand. GM is planning to use this technology for some of its V-8 and V-12 engines, and the technology can likely be applied in V-6 engines as well.

One final thing to note is that the engine specific power level is not the only measure of engine efficiency. While there is little room to significantly improve the indicated, or thermal engine efficiency for a spark-ignition gasoline engine, there is tremendous potential to improve part-load engine efficiency by reducing engine friction and pumping losses, resulting in an enlarged high efficiency area on the engine performance map. This can be largely achieved by reducing throttling losses through various valve-control technologies and is taken advantage of by the VTEC-E engine to improve engine efficiency throughout its operating map.

Advanced Transmissions

Very substantial progress in transmission efficiency can also occur. Three types of design improvements are: (1) added gears in conventional transmissions, e.g., 5- and 6-speed automatics, with optimal gear-shift strategy enabled by variable-shift schedule control; (2) motor driven gear shifting ("automatic manual transmission"); and (3) continuously variable transmissions. Additional gears enable the engine to run at a lower average speed over the range of vehicle speed and acceleration conditions, resulting in reduced engine friction. The ultimate in optimizing engine speed over driving conditions is the very wide span and "infinite" number of gears afforded by the continuously variable transmission (CVT).

Automatic manual transmissions - AMT (known as "motorized gear shift" or "motor driven gears") are being adopted in production vehicles starting in Europe. The AMT is an evolution of the manual transmission which not only automates for driver convenience, but opens the opportunity for detailed programming of shifting, enabling fast and very smooth shifting without a torque converter. While the application of CVT on some heavier light-duty trucks might be limited by its maximum torque capability in the near term (currently about 200 lb.ft), the AMT has less torque limitation, especially when coupled with 42-volt electric system. The CVT and AMT are considered without torque converter. Note: a CVT now comes standard with the all wheel drive version of the Saturn VUE SUV.

LOAD REDUCTION

Mass Reduction

Net reductions in vehicle curb weight are achievable by redirecting product design priorities and taking advantage of more marked materials changes, such as aluminum-based structures, and new ways to design components and structures, such as composite panels on space frames.

Automakers have identified approaches to achieve as much as 40% mass reduction from passenger cars (as demonstrated by aluminum-intensive Ford P2000 when compared to a conventional Taurus), and are working on ways to bring down the cost. These approaches target body structures as well as suspensions and other chassis parts along with closures and interiors. We assume up to 10% mass reduction for light duty trucks, depending on the case.

Streamlining

Aerodynamic drag can be reduced through streamlining. Drag is proportional to the product of a vehicle's frontal area and a drag coefficient (C_D). Frontal area cannot be much reduced without downsizing the vehicle, so the technical opportunity is for ongoing streamlining to reduce C_D. In the United States, as for other fuel-efficiency measures, streamlining benefits have been partly offset by the increased frontal area due to vehicle upsizing. Current C_D values are 0.30–0.35 for cars and 0.40–0.45 for light trucks. Fleetwide C_D has decreased about 2.5%/yr over the past two decades and it is not uncommon to see a 15% reduction when a vehicle is redesigned. Given the low C_D values of today's best designs and the even lower values demonstrated in concept cars, this rate of improvement can continue for at least another decade. We assume a roughly 10% reduction in drag coefficient for the current representative vehicles we analyze.

Tire Rolling Resistance

Tire rolling resistance, represented by the coefficient C_R, can be reduced though new materials and design. Lower-friction tires continue to be introduced as original equipment to help meet CAFE standards, although shifts toward larger tires for reasons of performance and image partly offset the benefits. Reductions in C_R through improved rubber compounds and design do not compromise safety and handling. The potential for such improvements over a decade time frame is 15%–30%. We assume a 20% C_R reduction for the vehicles we analyze, reducing the tire rolling resistance coefficient from current light-duty truck levels of 0.012 to 0.010. This tire rolling resistance coefficient is still much higher than the levels achieved in passenger cars, which have reached below 0.007, to meet higher traction performance demand for trucks.

INTEGRATED STARTER-GENERATOR

The historically gradual evolution of automobile electrical systems is about to give way to revolution in design with integrated starter-generator ("ISG") to power an electric system. While the crankshaft-mounted ("On-shaft") ISG designed for 42-volt operation (with a 36-volt battery) are most promising for near future, a belt-driven design of starter-generator (SG) has drawn attention for low-cost implementation with current vehicle systems [17-19]. A belt-driven SG is often easier to package than a crankshaft-mounted ISG, which require powertrain modification and in many cases a longer package. The belt-driven system can offer many similar benefits of the crankshaft-mounted system, however, its functionality is limited by its maximum power capability - about 3.5 kW.

Although there will be transition costs in moving toward 42 volt architecture, cost savings are likely to dominate in the long run given the need to meet growing demands for on-board power. From a fuel economy point of view, the ISG provides numerous benefits, including: high efficiency, engine start/stop, and some torque augmentation to aid launch and smooth shift transitions. The ISG can permit the transmission to operate more frequently in lockup mode and can even allow elimination of the torque converter when combined with advanced transmissions. Take off power @ 110 volts should also be marketable.

In our analysis we will consider the following two SG systems: 1) a low-cost belt-driven 3kW SG system providing sufficient cranking torque to enable fast engine restart after vehicle stops, and 2) an integrated 42-volt 3kW ISG system providing electric steering and braking, torque smoothing and launch assist, and engine shut-down during vehicle stop and hard deceleration. These systems are considered to take advantage of energy waste during vehicle stops and hard deceleration (or braking deceleration, deceleration when brakes are applied).

Table 3 lists the time and fuel use shares during vehicle stops and braking decelerations for the three light-duty trucks under the FTP cycle. The results are based on MEEM simulation. It shows that vehicles spend significant and about equal time and fuel during braking decelerations and stops. It shows that up to 9-11% of total fuel consumption is wasted during vehicle stops, and additional 10-13% during braking deceleration. Engine start/stop can be designed to avoid engine idling during vehicle stops only, or during both vehicle stops and braking deceleration when engine doesn't deliver power. The fuel saving would be much higher for the latter case. However, during vehicle stops and to lesser extent in braking deceleration, accessories must be operated from the battery, so the potential fuel savings are less than the fuel use during these periods.

Table 3. Time and fuel consumption during vehicle stops and braking in the FTP cycle, based on MEEM

	vehicle stops		vehicle braking		Total engine idle	
FTP Cycle	pct time	pct fuel	pct time	pct fuel	pct time	pct fuel
Silverado	19.2	9.4	21.9	10.7	41.1	20.1
Caravan	19.2	11.2	22.8	13.3	42.0	24.5
Explorer	19.2	10.8	21.6	12.2	40.8	23.0

FUEL ECONOMY POTENTIAL

In our view, fuel economy potential is best determined using a technology package approach. A technology package is an integral component of system modeling approach. Instead of lump-summing individual technology gains, a technology package involves multiple technologies and integrates them into vehicle system through system modeling tools.

TECHNOLOGY POTENTIAL

As discussed earlier, these technologies are either readily available from some production models, or soon to be implemented in production vehicles in near future. The individual fuel economy benefits of these measures applied to the baseline vehicles are estimated by using the MEEM model. Table 4 shows the results. The LTD column in the Table 4 represents the results of fleet average light-duty trucks. All Table 4 figures are based on the combined EPA city/highway cycles. These results are also based on performance-equivalent basis, which means that the 0-60 time is maintained constant throughout our analysis.

Table 4. CAFE Fuel Economy Benefits of Individual Measures Compared to MY 2001 LDTs

Technology	Silverado	Caravan	Explorer	LTD
Basic Streamline and Tire Drag Reduction	5.6%	5.1%	5.6%	5.5%
10% Weight Reduction	8.2%	7.7%	7.9%	8.0%
Engine	6.1%	13.6%	12.7%	9.2%
Belt-driven SG	5.5%	7.0%	5.8%	5.9%
On-Shaft 42 Volt ISG	10.2%	13.3%	10.7%	10.9%
Transmission - CVT or AMT-6	6.9%	8.8%	9.0%	8.1%

These results represent the fuel economy benefits of individual measures over the baseline technologies. Please note that these results are not incremental benefits in the apparent list order. Our internal analysis has indicated that the sequence of technologies, as they applied over different baseline cases, can significantly influence the outcome of the benefits.

Table 4 shows that, averaged over truck fleet, the basic streamline and tire drag reduction measures can yield fuel economy gains of about 5.5%. The 10% weight reduction can result in 8% increase in fuel economy on the performance-equivalent basis.

Larger benefits come from the integrated-efficient engine measure, where a 54 kW/L VTEC-like engine is used to replace baseline engines for minivans and SUVs. The fuel economy benefit for Explorer is about 12.7%. The highest fuel economy benefit belongs to the Caravan. The 54% improvement in specific power from baseline engine (35 kW/L) to advanced high speed VTEC-like engine (54 kW/L) can boost fuel economy 13.6% in the combined city/highway cycles. The baseline engine plus displacement-on-demand for the Silverado provides a 6% improvement in fuel economy. Averaged over entire truck fleet, the integrated-efficient engine options can boost fuel economy by more than 9%.

Both belt-driven SG and 42-volt on-shaft ISGs can boost fuel economy significantly. For the belt-driven SG, about 6% fuel economy benefit can be achieved over the truck fleet. In assessing engine start/stop benefit, we assume the engine will be turned off only during vehicle stops. However, as demonstrated in Table 3, fuel consumption during vehicle deceleration with braking, where engine doesn't deliver power at all, is also quite significant. Our internal investigation also reveals that, the fuel cut-off effects during vehicle deceleration in the FTP cycle are small or nonexistent for late 1990's vehicles. This means that a more aggressive fuel, or even engine, cut-off strategy, when applied with the 42-volt on-shaft ISG, can result in higher fuel savings, averaging near 11% over light-duty truck fleet.

Lastly, the fuel economy gains associated with advanced transmission systems, such as CVT and AMT, are also significant. Averaged over the truck fleet, it can improve fuel economy by 8% over the combined CAFE cycle.

TECHNOLOGY PACKAGES AND FUEL ECONOMY

Based on the previous discussion, we have put together several technology combinations or packages to assess fuel economy potentials for the selected three baseline trucks. Table 5 summarizes these combinations.

In Table 5, all technology packages include the basic streamline measure, which includes air and tire drag reduction and engine idle-speed reduction. All packages also include either an integrated efficient engine measure, which replaces baseline gasoline engines with a 54 kW/L high-efficiency engine for the Explorer and Caravan, or displacement-on-demand technology for the Silverado. Beyond these two measures, each of the first three packages involves *one* of the following three additional measures: 10% weight reduction, belt-driven ISG with idle-off capability, and advanced transmission with CVT or AMT. These combined measures can achieve significant fuel economy gains. Averaged over the truck fleet, the fuel economy levels of the first three new packages can reach 27 to 28 MPG based on combined CAFE cycle (55% CITY and 45% HWY cycles), up to a one third increase over the current fleet level. The biggest improvement potentials are from SUVs and minivans, where fuel economy gains of up to 38% can be achieved.

Table 5. Technology Packages and CAFE Fuel Economy Potential

Technology Packages	*Base*	1	2	3	4
Basic Streamline		X	X	X	X
Engine		X	X	X	X
10% Weight Reduction		X			X
Belt-driven SG			X		
Transmission – CVT or AMT-6				X	X
On-Shaft ISG with 42 Volt System					X
Silverado					
MPG	21.0	26.2	26.2	26.8	31.1
Gains		25%	25%	28%	48%
Caravan					
MPG	22.3	30.0	29.1	30.8	35.8
Gains		35%	30%	38%	61%
Explorer					
MPG	21.2	27.8	27.0	28.1	32.7
Gains		31%	27%	33%	54%
LTD					
MPG	**21.3**	**27.6**	**27.1**	**28.1**	**32.6**
Gains		29%	27%	32%	53%

System Analysis Approach vs. Multiplicative Approach

A peripheral issue is the computational differences between system analysis approach used by this and the ACEEE studies [2, 6], and multiplicative technology menu approach used by NRC and other studies [1, 4, 5]. Generally speaking, there are two tendencies associated with the multiplicative approach: 1) it can underestimate combined benefits when there is a synergism between considered technologies, as the cases demonstrated here; or 2) it can overestimate the combined fuel benefits when the considered technologies are overlapping and competing for same energy saving resources. This is the case demonstrated by some technology combinations presented in the NRC report.

Table 6 compares the methodological gaps between the system analysis approach vs. multiplicative approach. While the system results are directly from Table 5, the multiplicative results are based on individual technology gains presented in Table 4.

As seen in Table 6, the system approach shows that the fuel economy gains are larger than indicated by the multiplicative approach. Averaged over light-duty-truck fleet, the methodological gaps range from 4% in Package 4 to 7% in Package 3. These gaps are due to the failure of the multiplicative approach to take into account the ability of many of the technologies to work more effectively together than alone.

Table 6. System Analysis Approach vs. Multiplicative Approach and Methodological Gaps

Technology Packages	Silverado	Caravan	Explorer	LTD
Package 1				
System results	25%	35%	31%	29%
Multiplicative	21%	29%	28%	24%
Methodological gap	3.5%	5.9%	2.7%	4.9%
Package 2				
System results	25%	30%	27%	27%
Multiplicative	18%	28%	26%	22%
Methodological gap	6.6%	2.7%	1.4%	5.0%
Package 3				
System results	28%	38%	33%	32%
Multiplicative	20%	30%	30%	24%
Methodological gap	7.8%	8.2%	2.8%	7.2%
Package 4				
System results	48%	61%	54%	53%
Multiplicative	43%	59%	55%	49%
Methodological gap	5.3%	2.0%	-0.7%	4.0%

2. Safety

The key to making safe vehicles is in their design: high-strength, lightweight materials allow vehicles to be designed to reduce weight and retain their size while achieving enhanced crash management performance. Reducing weight is only one of the technology approaches automakers can take in improving vehicle fuel economy, and it can be done without reducing size. All of the other approaches, focused on in the NAS study, will have no effect on vehicle safety.

The recent study by Dynamic Research, Inc. (<http://www.dynres.com/index.htm>), indicates that weight does not play a statistically significant role in the safety of modern cars and light trucks. The study also further emphasizes the role that vehicle weight distribution and light truck aggressivity play in vehicle safety: indicating that reducing the weight of light trucks will save lives. Thus if automakers do choose to reduce the weight of their light trucks as a result of NHTSA rulemaking, there will be a safety benefit, in line with one of the primary concerns of NHTSA. The technology to achieve weight reduction in light trucks is well know has been investigated by the American Iron and Steel Institute in their light truck structure study (<www.autosteel.org/press_release_output.php3?prjob_num=1016>).

The key role weight plays in vehicle safety is based on the disparity between vehicles, not the average weight of the vehicle fleet. As the number of heavy vehicles on our highways has increased with the SUV sales boom, disparity has increased, undermining safety, not improving it. Reducing the weight and improving the design of SUVs and other light trucks will protect drivers and complement the goal of improved fuel economy. As a result, while NHTSA considers raising fuel economy, it should also consider vehicle aggressivity regulations that will reduce the risk imposed by heavy/tall vehicles. This can be addressed through the National Highway Traffic Safety Administration prescribing a motor vehicle safety standard that will reduce the average amount of damage suffered by passenger automobiles in collisions with light trucks. This rule can be supported by significant NHTSA documentation that has investigated the aggressivity issue such as the following reports: DOT-HS 808 679, Vehicle Aggressivity: Fleet Characterization Using Traffic Collision Data; and DOT HS 809 194, Vehicle Design versus Aggressivity.

Further, in focusing on the issue of safety and design, NHTSA should consider addressing the SUV rollover fatality issue. Fatalities from rollovers represent the second largest fatality category in year 2000 accident data and are a function of vehicle design. NHTSA, in considering safety concurrently with fuel economy standards should also consider prescribing a motor vehicle safety standard for rollover crashworthiness standards that includes: (1) dynamic roof crush standards; (2) improved seat structure and safety belt design; (3) side impact head protection airbags; and (4) roof injury protection measures.

4. Regulation Timeline

The past limitation of a 1 year regulatory cycle hampered NHTSA and automakers from taking advantage of the certainty that longer range regulation provides. The 2005-2010 timeline provides additional regulatory certainty for automakers in developing their production plans. The longer timeline would enable automakers to shift their planning more towards fuel economy instead of power and size, thus enabling higher targets to be met. This timeline, however, would be compromised if minimal fuel economy targets are set and the ability of the automakers to take advantage of the enhanced certainty is not taken advantage of.

Based on Ford's promise of a 25% improvement in the fuel economy of their SUVs by 2005 and assuming Model Year 2000 sales, this represents a 7% increase in their light truck fleet fuel economy. Based on GM's announcement that it will beat Ford on fuel economy in the LDT market and DaimlerChrysler's claim that it will do so across their whole model line (approximately ¾ of which are light trucks), a 7% improvement in light truck fuel economy seems to represent a solidly technically achievable increase by 2005. NHTSA can thus set a 2005 standard for light trucks can be set to at least 22 mpg which represents a 6.3% increase, thus not even holding the industry to the precedent set by Ford. By 2008 at the latest, we recommend setting light truck fuel economy to 27.5 mpg, to bring light trucks up to current car standards. Our technical analysis indicates that this can be achieved solely by incorporating variable valve engines similar to the Honda VTEC, minor aerodynamic and rolling resistance improvements and the use of either CVTs or automatic manual transmissions, all of which exist in vehicles today. By 2010, we recommend a light truck standard of at least 30 mpg and as high as 33 mpg, with the 30 mpg level being achievable with NAS path 2 technologies and the 33 mpg being achievable with the additional application of safety-enhancing weight reductions.

4. Benefits

Based on the same methodology used in Drilling in Detroit, our analysis indicates that the 2008 target which would bringing light trucks to the fuel economy level of today's cars will save at least one million barrels of oil per day by 2020 if phased in over the NHTSA timeline. Reaching an average light truck fuel economy of 32.6 mpg by using existing technology along with Integrated Starter Generators over the NHTSA timeline would result in saving 1 million barrels of oil per day by 2014 and over 1.7 million barrels of oil per day by 2020. This translates into greenhouse gas savings of about 50 to 80 million metric tons of carbon equivalent per year. The latter case represents a reduction in oil consumption and global warming emissions from passenger cars and light trucks of 10% in 2014 and 15% in 2020. Finally, consumers would be saving between $1,200 and $2,200 over the life of their vehicle – this indicates that in the cost benefit analysis there is actually a net savings achieved in providing the oil use and global warming gas emissions reductions. This savings and the investments made by automakers will create new jobs both in the domestic auto industry and throughout the US economy.

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The following section represents the financial and environmental savings estimates for the packages analyzed in the forthcoming SAE paper 2002-01-1900: Near-Term Fuel Economy Potential for Light-Duty Trucks. In all cases, the technologies that could be employed to meet higher light truck fuel economy standards would save consumers money while reducing oil use and global warming emissions.

COSTS AND SAVINGS

Individual component cost estimates for our scenarios are presented in Table 7. Retail price estimates for streamlining, weight reduction, and the transmissions are from DeCicco et al. 2001 [2]. As in DeCicco et al., costs for mass reduction do not come into play until the mass is reduced by 15%. Studies have shown that a moderate degree of mass reduction can be obtained at no cost increase, even at a cost savings, though the use of manufacturing and materials refinements (for example AISI [20, 21]). Costs for the automatic manual/powershift transmission without torque converter are also assumed to be zero as it is expected to be less complex and require less material than automatic transmissions, with the tradeoff of requiring increased electronics.

The retail price estimate for the 42 V ISG is a conservative value taken from the high cost scenario for the 42 Volt electrical systems and the integrated starter generator items analyzed in the recent NRC fuel economy report [1]. The retail price estimate for the belt driven starter generator and 42 Volt system is based on the average 42 V system cost plus half the average ISG cost from the NRC fuel economy report [1]. The engine costs are derived from DeCicco et al. [2], but increased to account for the more advanced engine version. In the case of the Silverado engine, the average retail price estimate for cylinder deactivation from the NRC fuel economy report was added to cover the additional cost of an engine which uses that operating mode.

Table 7. Estimated Retail Price Estimate of Individual Technologies (2000$)

Technology Path	Silverado	Caravan	Explorer
Basic Streamline	$182	$180	$178
10% Weight Reduction	-	-	-
Engine	$182	$460	$370
Belt Driven SG	$315	$315	$315
On-Shaft 42 V ISG	$630	$630	$630
Transmission AMT 6	-	-	-

Table 8 presents a summary of the costs and savings for each of the packages. The retail price estimates are simply the sum of the costs of the appropriate technologies, while the fuel cost savings are calculated based on an average gasoline cost of $1.40, a 15 year vehicle lifetime with a declining average annual mileage that totals to 170,000 miles during the vehicle life. All lifetime values in Table 6 represent net present value with a discount rate of 5% - the real interest rate associated with an 8% vehicle loan.

Table 8. Summary of Retail Price Estimates and Savings for Each Light Truck Scenario.

	Baseline Vehicle Price	*1*	*2*	*3*	*4*
Silverado	$23,334				
Price Increase		$ 364	$ 679	$ 364	$ 994
Lifetime Fuel Savings		$ 2,077	$ 2,077	$ 2,265	$ 3,399
Net Savings		$ 1,713	$ 1,398	$ 1,901	$ 2,405
Caravan	$33,065				
Price Increase		$ 640	$ 955	$ 640	$ 1,270
Lifetime Fuel Savings		$ 2,530	$ 2,303	$ 2,720	$ 3,717
Net Savings		$ 1,890	$ 1,348	$ 2,080	$ 2,447
Explorer	$29,915				
Price Increase		$ 548	$ 863	$ 548	$ 1,178
Lifetime Fuel Savings		$ 2,461	$ 2,227	$ 2,546	$ 3,667
Net Savings		$ 1,913	$ 1,364	$ 1,998	$ 2,489
Average LDT					
Price Increase		$ 668	$ 983	$ 668	$ 1,298
Lifetime Fuel Savings		$ 2,355	$ 2,209	$ 2,497	$ 3,577
Net Savings		$ 1,687	$ 1,226	$ 1,829	$ 2,279

Packages 1 and 3 do not use any form of the starter generator to achieve their fuel economy improvements and are therefore the least expensive options. In both cases, light truck fuel economy is brought above the current fuel economy standard for cars and even reaches above the current car fleet average of 28.1 mpg. In both cases, the consumer will save $2,000 to $2,700 at the gasoline pump over the life of the vehicle, more than four times the initial cost of the added technologies.

Package 2 achieves a slightly lower improvement in fuel economy at a higher price. Initially this may seem to indicate that the belt driven SG is not a good candidate for moderate fuel economy improvements. However, the added cost of the SG system also comes with added opportunities and features for consumers. In addition, the idle-off feature reduces vehicle noise and vibration at stops and in traffic. These features alone could justify the added cost for some consumers, with the improved fuel economy coming along as a bonus.

Package 4 brings in all of the technologies considered and upgrades to a fully integrated starter generator. The use of the more advanced ISG system along with the other fuel saving measures increases the fuel economy further at a moderate price increment. The increase in fuel economy for these vehicles brings the consumer savings at the gasoline pump up to an average of $3,500, or about 1.5 times that seen in Packages 1 and 3. These savings are close to three times the cost of the fuel economy improvements for Package 4.

BROADER IMPACTS

The effects of increasing fuel economy go beyond the savings seen by the consumer. The oil that is required to produce fuel for today's vehicles contributes heavily to our trade deficit, our vulnerability to oil price shocks, and our overall energy security. In addition, the production and use of fuel to run these vehicles results in significant emissions of global warming gasses. Table 9 indicates that the cost effective increases in fuel economy that result from the various packages investigated here also produce significant reductions in oil use and global warming emissions. Over the life of these light trucks, 48 to 85 barrels of oil would never have to be pulled out of the ground for each one that is sold instead of today's average light truck. Based on recent sales, we can estimate that 7.5 to 8 million light trucks are sold each year – resulting in a savings of 360 to 680 million barrels of oil saved from one year's worth of light truck sales.

Table 9. Summary of Oil and Global Warming Savings for Each Light Truck Scenario.

	1	*2*	*3*	*4*
Silverado				
Lifetime Oil Savings per Vehicle (barrel)	47.8	47.8	52.1	78.2
Lifetime Global Warming Gas Savings (MTCE)	6.0	6.0	6.5	9.7
Caravan				
Lifetime Oil Savings per Vehicle (barrel)	58.2	53.0	62.6	85.6
Lifetime Global Warming Gas Savings (MTCE)	7.2	6.6	7.8	10.6
Explorer				
Lifetime Oil Savings per Vehicle (barrel)	56.7	51.3	58.6	84.4
Lifetime Global Warming Gas Savings (MTCE)	7.1	6.4	7.3	10.5
Average Light Duty Truck				
Lifetime Oil Savings per Vehicle (barrel)	54.2	50.8	57.5	82.3
Lifetime Global Warming Gas Savings (MTCE)	6.7	6.3	7.2	10.2

Those same vehicles save an average of 6 to 10.6 metric tons of carbon equivalent (MTCE) global warming gas emissions per vehicle from the reduced production, distribution and use of gasoline. One year's worth of light truck sales would then represent a savings of 45 to 85 million metric tons of carbon equivalent (MMTCE) global warming gasses.

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The following section is an analysis we performed to evaluate the employment impacts of reaching 40 mpg by 2012. While this goes beyond the timeline being considered by NHTSA and also includes passenger cars, it shows the overall direction of the impact that raising fuel economy standards will have on the US economy. This is a positive impact, which includes increases in domestic jobs in the auto industry as well as in every other sector in the US economy. The impact of increasing light truck fuel economy alone, will not be as large as is shown below for a 40 mpg fleet.

Fuel Economy as an Engine for Job Growth

The economic growth of our nation is tied to technological innovation. From the steam engine and the automobile to the microchip, a "can do" attitude of aggressive technology development has created millions of jobs and enormous wealth. Now, however, many in the auto industry have stepped back from this path. Technologies that could enable cars and trucks to go farther on a gallon of gasoline are being left on the shelf.

The Union of Concerned Scientists estimated the effect that increasing fuel economy standards to an average of 40 miles per gallon by 2012 would have on jobs in the year 2015. We found that, in 2015, the benefits resulting from investments in fuel economy could lead to 182,700 new jobs throughout the country, with California, Michigan, New York, Florida, and Ohio topping the list. In the automotive sector alone, over 41,000 new jobs could result. Rather than constricting the industry, as automakers often claim, increasing fuel economy could push technological innovation and lead to investments that will benefit the auto industry and its employees.

Fuel Economy and Job Creation:
Investments in fuel economy technology will create jobs in two ways:

- Consumer Re-Spending: Cars and trucks that go farther on a gallon of gasoline will save consumers money – less money spent at the gas pump means more money spent in other sectors of the economy. Some of that shift in spending would go back to the automobile industry to pay for the fuel economy improvement, creating create jobs in the motor vehicle sector. The remainder would benefit a variety of industries, creating jobs in manufacturing, agriculture, construction, and the service industry, among others. This is the opposite side economic equation from the oil price shocks and subsequent recessions that occurred in the early 1970s, the late 1970s/early 1980s, and the early 1990s.

- Automotive Industry Investments: To improve fuel economy, automobile manufacturers and their suppliers would invest in new tooling and machinery, putting the technology they have developed to work. These investments would create jobs throughout the auto and finance industries. Passing these costs on to consumers – whose gasoline savings would outstrip the small increase in vehicle price – would more than cover the costs of increasing the workforce. When combined with jobs from consumer re-spending, these investments could boost the motor vehicle industry by 41,000 new jobs.

Consider this example: A pickup truck with the same performance, comfort, and safety available today could reach 31 mpg with existing technology. This improved pickup would save its owner about $3,400 over the life of the vehicle, compared to a retail price increase of less than $1,000.[i] That leaves $2,400 to spend elsewhere in the economy. The $1,000 price increase goes back to the automotive industry to cover investment and labor, with room for increased profit. This represents a 4.3% price increase over 10 years for the truck – less than half the historical price increase of an average passenger vehicle, which was about 9% from 1989 to 1999.[ii]

Analysis Methodology:
To estimate the potential employment impacts resulting from investments in fuel economy technology, we used industry-specific data derived from a macroeconomic impact analysis tool called IMPLAN (Impact Analysis for PLANning).[iii] This model incorporates interactions among 528 industrial sectors using 21 economic variables to trace supply linkages and evaluate how changes in spending impact employment, wages and salary, and the national gross domestic product. To estimate the costs and savings from increasing fuel economy to 40 mpg by 2012, we used a vehicle stock model developed by the Union of Concerned Scientists and a modified version of cost/performance analyses by the American Council for an Energy Efficient Economy[iv].

With these costs and savings and the industry-specific data from IMPLAN, we analyzed both the direct and the indirect investments generated by the technology improvements, as well as the re-spending of fuel cost savings. The analysis provided a national industry-by-industry breakdown of job impacts for the year 2015. We allocated the national impacts among the states using gasoline consumption and prices in each state, along with state employment projections for each industry from the Bureau of Labor Statistics and the Bureau of Economic Analysis.[v]

Both industry-specific and state-by-state analysis results represent estimates of the magnitude employment impacts based on historical relationships. These estimates are subject to changing economic conditions, but indicate the strong positive directional effects of improving fuel economy.

Sector-by-Sector Analysis:
Table 1 shows the results of the sector-by-sector analysis of raising fuel economy to 40 mpg by 2012. By 2015, the motor vehicle industry could, we estimate, add over 41,000 jobs, while the overall economy could gain more than 182,000 new jobs.

Only the oil industry, and those industries tied to it, would be likely to lose jobs. For example, the decline in demand for gasoline brought about by improved fuel economy would shift 48,000 jobs from the industries responsible for extracting, refining, and transporting crude oil and those that transport and sell gasoline. These jobs might well shift into the service sector, for example, which we estimate would see an increase of over 66,000 jobs.

Table 1. Projected Increase in Jobs from Raising Fuel Economy Standards to 40 mpg by 2012 ***(by industry in the year 2015)***

Industry	**Net Increase in Jobs in 2015**
Agriculture	7,700
Construction	12,300
Finance, Insurance, Real-estate	31,900
Government	3,400
Manufacturing (excluding Motor vehicles)	29,900
Mineral and Resource Mining and Petroleum Refining	(24,900)
Motor Vehicles	41,100
Retail Trade	22,500
Services	73,900
Transportation, Communication and Utilities	8,100
Wholesale Trade	(23,200)
Total	**182,700**

State-by-State Analysis:
Our estimates suggest that every state would see some benefit from the investments in fuel economy technology, as Table 2 shows. In some states, the growth would be linked primarily to consumers re-spending the savings they accrue from improved fuel economy. Other states could experience additional benefits because they have a greater share of the industries that see more job growth. Our results suggest that, in 2015, California would show the largest growth with 23,600 jobs, followed by Michigan with 11,500 and New York with 10,100. Ohio, Florida, Texas, Illinois, and Pennsylvania would not be far behind, adding 7,000 to 9,000 new jobs in 2015.

Table 2. Projected Increase in Jobs from Raising Fuel Economy Standards to 40 mpg by 2012
(by state in the year 2015)

State	Net Increase in Jobs in 2015	State	Net Increase in Jobs in 2015
AK	200	NC	5,800
AL	3,000	ND	400
AR	1,700	NE	1,100
AZ	3,100	NH	800
CA	23,600	NJ	4,700
CO	2,500	NM	800
CT	2,400	NV	1,200
DC	500	NY	10,100
DE	700	OH	9,200
FL	9,700	OK	1,100
GA	5,100	OR	2,400
HI	700	PA	7,400
IA	2,000	RI	600
ID	800	SC	2,700
IL	7,900	SD	500
IN	5,500	TN	4,600
KS	1,400	TX	9,100
KY	3,000	UT	1,500
LA	1,300	VA	4,700
MA	4,100	VE	400
MD	3,300	WA	4,000
ME	800	WI	3,900
MI	11,500	WV	800
MN	3,400	WY	100
MO	4,100		
MS	1,600		
MT	500	***Total***	**182,700**

Progress, not Empty Rhetoric:
The automobile industry often cites job-loss figures at odds with the results of our analysis. Such statements are part of a long history of claims that fuel economy, safety, and environmental improvements will have a negative impact on jobs and the viability of their business. In 1970, Earnest Starkman, then vice president of General Motors, argued that the Clear Air Act Amendments of 1970, which required the installation of catalytic converters in automobiles to

reduce vehicle emissions, presented "the prospect of an unreasonable risk of business catastrophe…" Going further, he stated, "It is conceivable that complete stoppage of the entire production could occur, with the obvious tremendous loss to the company, shareholders, employees, suppliers, and communities."[vi]

Similar arguments are being resurrected during the current debate over the need to increase fuel economy standards. For example, an Associate Press article on February 4, 2002, quotes Gloria Bergquist, spokeswoman for the Alliance of Automobile Manufacturers, on a proposal to increase fuel economy standards: "Light trucks will no longer exist under this," she said. "It's a job killer. You can kiss your SUV, minivan and pickup goodbye."

But these arguments are rhetoric, not reality – in fact, the low fuel economy of our passenger vehicles makes us more susceptible to job loss and recessions resulting from oil price shocks.

This study shows that increasing fuel economy standards means more jobs throughout the economy, in every state, and in the auto industry. It is a question of putting production workers and engineers to work building better cars, SUVs, minivans and pickup trucks rather than relying on dire predictions to hold back necessary progress.

Cost and savings analysis performed by David Friedman, Union of Concerned Scientists
Macroeconomic modeling performed by Marshall Goldberg, MRG & Associates

5. The National Academy of Sciences CAFE study

Commentary on the National Academy of Science/National Research Council Report
The following are brief comments on some of the key sections of the NAS/NRC fuel economy panel report. This is not intended to be an exhaustive analysis and critique of the report, but instead highlights issues of key concern to UCS.

Rational for Regulation of Fuel Economy

The NAS/NRC panel report provides clear justification of the value of regulating fuel economy. In their first recommendation it is stated that, "Because of concerns about greenhouse gas emissions and the level of oil imports, it is appropriate for the federal government to ensure fuel economy levels beyond those expected to result from market forces alone." (page 6-6)[1]. UCS firmly agrees with this statement. Based on our assessment of the available technologies and the impacts of their use, we believe that a near term goal of closing the light truck loophole by making light truck fuel economy standards the same as cars by 2007 provides significant net benefits to society. In the longer term, we believe that a goal of 40 mpg by the middle of the next decade is both technically achievable and also provides significant net benefits to society through consumer savings at the gas pump, reduced oil use, reduced global warming and other pollutant emissions, and reductions in highway fatalities.

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[1] Alternatively, the report also states that, "Regulations such as the CAFE standards are intended to direct some of industry's efforts toward satisfying social goals that transcend individual car buyers' interests." (page 2-16)

Fuel Economy Assessment

Overall, UCS analyses agree with the general results for potential fuel economy improvements and associated costs using what the NAS/NRC terms existing and emerging technologies. Under some specific comparisons, UCS estimates of fuel economy are somewhat higher than those of the NAS/NRC. One key reason for this is that our estimates are based on detailed vehicle modeling that ensures inclusion of the synergistic effects between technologies that the NAS/NRC menu approach can miss. Another key reason for the difference is that in our analysis we rely more heavily on safety enhancing weight reductions for the light truck class, which enables higher levels of fuel economy to be reached at lower costs.

One significant concern in the NAS analysis is the classic economic analysis that is termed an "economic efficiency analysis" and actually finds the point where the net savings over the life of the vehicle is at its maximum. **Thus, the analysis performed by the NAS/NRC panel theoretically identifies the fuel economy levels where consumers save the most money.** This analysis, however, does not represent an assessment of the social benefit of improving fuel economy, only the degree to which a rational individual might seek to maximize their investment.

I have performed an additional analysis using the results for the Path 2 technologies as identified in the NAS/NRC report on page 45. The results for the average cost/average fuel economy level in Path 2 are presented below assuming a reasonable social discount rate of 5% (this discount rate corresponds to an 8% new car loan, corrected for inflation).

Path 2, 5% discount rate			Average		
	Base mpg	Base Adj mpg	FE (mpg)	Incremental Cost	Net Savings
Cars					
Subcompact	31.3	30.2	37.5	$ 1,018	$ 305
Compact	30.1	29.1	36.6	$ 1,088	$ 369
Mid Size	27.1	26.2	36.0	$ 1,642	$ 519
Large	24.8	24.0	34.5	$ 2,167	$ 478
Light Trucks					
Small SUVs	24.1	23.3	31.4	$ 1,543	$ 745
Mid SUVs	21.0	20.3	30.8	$ 2,227	$ 1,289
Large SUVs	17.2	16.6	24.7	$ 2,087	$ 2,025
Small Pick-ups	23.2	22.4	34.0	$ 2,227	$ 945
Large Pick-ups	18.5	17.9	28.2	$ 2,542	$ 1,738
Mini Van	23.0	22.2	34.0	$ 2,227	$ 1,031
Average Car	28.2		36.2	$ 1,162	$ 368
Average Light Truck	20.3		30.1	$ 2,254	$ 1,324
All	23.9		33.1	$ 1,665	$ 809

Here we see that consumers are saving between $300 and $2,000 above the cost of the fuel economy improvements for different vehicles. The average light truck fuel economy is 30 mpg with an average cost of $1,300, based on Year 2000 sales. UCS estimates predict a higher fuel economy at this cost, however, the NAS/NRC results still demonstrate the ability to save money while achieving significant improvement in fuel economy.

One final issue related to the fuel economy assessments in the NAS/NRC report is the inclusion of their calculated externality values. The panel identifies the externalities associated with the oil market and the environmental impacts of gasoline use valued at $0.26 per gallon of gasoline. While we feel that this value is low, even this amount would show a net increase in savings to society from improved fuel economy standards. For example, in the average Path 2 example above, the average net societal savings of a 30-mpg light truck fleet fuel economy would be $2,000 per vehicle and would vary between $1,100 and $2,700, depending on the vehicle.

Safety

We disagree strongly with the majority of the assertions made by the majority panel regarding vehicle safety and fuel economy improvements. The key to making a vehicle safe is in its design. Proper design techniques, use of powerful computing resources and high strength materials enable designers to reduce the weight of vehicles while simultaneously including efficient crush space to absorb the impact in a crash and therefore reduce the forces experienced by the vehicle occupants. Existing crash data does not provide the ability to differentiate between vehicle weight, physical dimensions, and vehicle design and therefore statistical analysis based on this data **cannot** evaluate the direct relationship between changes and weight and changes in vehicle safety.

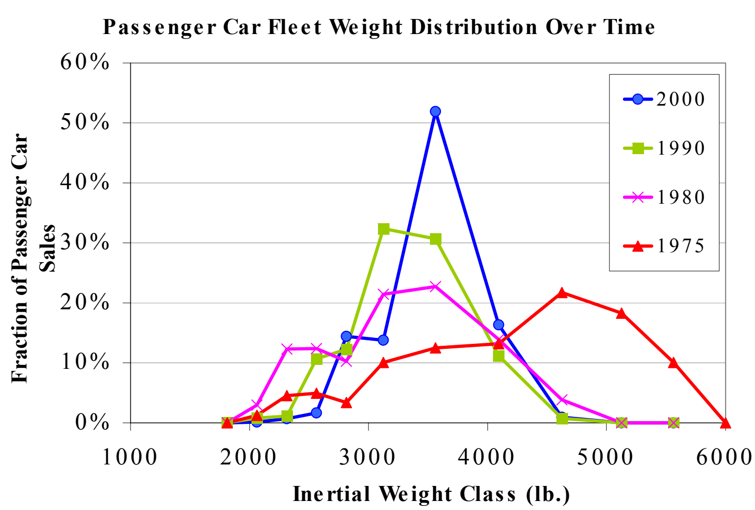
On the other hand, we agree generally with the findings of the panel minority in the dissent chapter on safety and note that significantly more analysis would need to be done before adequate quantification of the impacts on fuel economy changes on safety could be produced. These findings have been further substantiated by the recent Dynamics Research, Inc. report and the recent report from Ross and Wenzel.

In addition to the key problems raised in the dissent chapter, I would like to point out at least one conspicuous assertion that was made in the safety analysis. One of the key reasons why we reject the use of past data to assess current and future safety impacts of weight reduction is that vehicle technology is changing over time. On page 2-27 of the NAS/NRC report, an assertion is made that "the ratio of fatality risk in the smallest vehicles of a given type compared to the largest remained relatively similar." However, this ratio is never presented to the reader. Calculating this ratio for the data in the NAS/NRC Table 2-2 produced the following results:

vehicle type	vehicle size	occupant deaths per million registered vehicles one to three years old			Ratio of occupant deaths in a class relative to those in the heaviest vehicles of that class			% change in ratio over time	
		1979	1989	1999					
car	mini	379	269	249	2.37	1.95	1.87	-18%	-4%
	small	313	207	161	1.96	1.50	1.21	-23%	-19%
	midzise	213	157	127	1.33	1.14	0.95	-15%	-16%
	large	191	151	112	1.19	1.09	0.84	-8%	-23%
	very large	160	138	133	1.00	1.00	1.00	0%	0%
	all	244	200	138	1.53	1.45	1.04	-5%	-28%
pickup	< 3000	384	306	223	NA	3.26	1.94	NA	-40%
	3-3.9k	314	231	180	NA	2.46	1.57	NA	-36%
	4-4.9k	256	153	139	NA	1.63	1.21	NA	-26%
	5k +	0	94	115	NA	1.00	1.00	NA	0%
	all	350	258	162	NA	2.74	1.41	NA	-49%
SUVs	< 3000	1064	192	195	NA	1.29	2.12	NA	64%
	3-3.9k	261	193	152	NA	1.30	1.65	NA	28%
	4-4.9k	204	111	128	NA	0.74	1.39	NA	87%
	5k +	0	149	92	NA	1.00	1.00	NA	0%
	all	425	174	140	NA	1.17	1.52	NA	30%

All of the data above, other than the last columns labeled "% change in ratio over time" are the original data from the NAS/NRC report. The added columns above indicate that the ratio of fatalities in the smallest vehicles to the largest ones in each class changed during each 10 year period, with these changes being as high as a 64% increase for SUVs and a 40% decrease for pickups. Clearly the ratios did not remain either relatively similar over time, or among the classes. Even without the existing disagreements relative to the past safety data, this seriously threatens the validity of using the data to predict current or future safety impacts.

Further eroding their analysis is the fact that the type of vehicles in the fleet have changed drastically over time. The figure below shows how the weight distribution of cars has changed since CAFE was first passed. The key feature that stands out is that we used to have a lot of cars of many different weights with an overall high average weight. Now we have a lower overall average weight and the weight distribution is less spread out. **This means that changing the weight of today's vehicles has a much different effect than it would have in 1975 or even 1990 and therefore past data simply cannot be used to predict current safety performance.**



This issue of changing safety relationships over time brings to the fore another important issue, that of improved safety technology. Some of the differences above are likely attributable to improvements in the design of the vehicles as well as incorporation of improved safety technologies and/or better use of existing technologies. In our report, we have estimated the potential reductions in fatalities from simply increasing seat belt use from today's 70% up to 90% and found that 6,000 to 10,000 lives could be saved through increased seatbelt use. Improved safety belt design could save an additional 3,000 to 5,000 lives, for a total of 15,000 lives saved by safety belts alone. These potential life saving methods completely outweigh any negative safety impacts associated with weight/size reduction even if the majority analysis is accepted.

As noted above, however, we do not agree with the majority analysis. In our report, we demonstrate that it is the disparity in weight that is the key influence on safety and that influence is a negative one – the more you mix heavy and light vehicles, the less safe the highways will be. This fact is accentuated by the presence of light trucks that are heavy, stiff and have high bumpers. These three factors combine to make these vehicles very aggressive in crashes.

Analysis by Joksch et. al. indicates that in a front end collision, light trucks produce an increase in fatality risk by a factor of 3 to 5.6 when striking a car compared to a car striking a car.[2] In front-driver-side collisions light trucks pose risk factor 2 to 4.5 times that of a car when striking another car on the driver-side.[3] Further demonstrating the risks imposed by light trucks, recent analyses done by Ross and Wenzel shows that the top four selling cars in 1995-98[4] impose less of a risk in 2-vehicle crashes on other vehicles on the road than do SUVs and pickup trucks. For vehicles 2 to 5-years old, there were 79% more deaths per vehicle caused by the SUVs than by cars and more than four times as many deaths caused by pickups than by cars[5]. Correcting for the influence of age does not significantly alter these effects.[6]

Even more important are the findings by Ross and Wenzel that the risk of death in all crashes to the person driving one of the four best selling cars is **lower** than the same risk associated with driving one of the four best selling light trucks which are all heavier than the cars.[7] These results indicate that for modern vehicle designs with their associated size and weight, not only are the most popular cars less dangerous to others on the road, they are also safer for the driver compared to the top selling light trucks.

The NAS/NRC panel findings agree that reducing the weight and historically associated characteristics of light trucks could reduce the fatalities on our highways, however, in most of

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[2] Joksch, Massie, Pichler. *Vehicle Aggressivity: Fleet Characterization Using Traffic Collision Data"*. NHTSA. 1998. No vehicles had airbags. Data used was for 1991-1994.
[3] *Ibid.*
[4] The Taurus, Accord, Civic and Camry. *Wards's Motor Vehicle Facts & Figures 2000 for model years 1997 and 1998.*
[5] The Ford F Series, Chevy C/K pickup/Silverado, Explorer, and Ram Pickup. *Wards's Motor Vehicle Facts & Figures 2000* for model years 1997 and 1998.
[6] Risk by drivers for cars and light trucks provided in personal communication with Marc Ross and Tom Wenzel, September 7, 2001.
[7] Risk to drivers of top four selling SUVs is 26% higher than the risk to drivers in the top four selling cars and the risk to drivers of the top for selling pickups is 68% higher than that in the top four selling cars..

their fuel economy assessments they did not include weight reductions. In Path 3 where they did include some weight reduction, it was only 5% and was only in 3 of the 10 vehicles investigated, thus providing a very small benefit to safety. Our analysis indicates that a 10% weight reduction along with streamlining and an efficient variable valve controlled engine would enable light trucks to have the same fuel economy standard as cars. As indicated by Green and Keller, this would conservatively have saved 176 lives in 1993. Reaching higher fuel economy levels could require a 20-30 percent reduction in weight, implying a fatality reduction of 352 to 528. We feel that if more accurate assessments of the negative impacts of today's aggressive light trucks were developed, these fatality reductions would be further increased, especially since they can be achieved using high strength materials that maintain occupant safety while reducing aggressivity.

Weight Based Standards

The NAS/NRC report presents an altered fuel economy standard system termed E-CAFE, for Enhanced CAFE. A summary of the key impacts of this system is as follows:

- The weight based system creates incentives to add weight to smaller vehicles.
- As a result, this system creates a disincentive to adopt one of the most cost-effective fuel economy strategies (weight reductions) for many vehicles, one which PNGV has been working on for years.
- The weight based system also does not guarantee a specific fuel economy level and market shifts could still keep fuel economy on the decline.
- The NAS/NRC panel only provided an example of how the standards should be set. Evaluating and comparing the different impacts of various forms of the standard would be very complicated and leads to significant difficulty in setting fuel economy levels.

This system is predicated on a fuel economy standard that is based on a vehicle's weight. The heavier the vehicle the lower the required fuel economy, up to a weight cap, above which the fuel economy standard becomes constant (i.e. independent of weight as we have today). The cap creates an incentive for the heaviest vehicles to shed weight, which we agree seems like a positive step as it would improve overall vehicle safety, however it is, in essence, not very different from simply modifying the current flat light duty truck standard. The only difference is that some of the lightest trucks would not be included, they would instead be replaced by the heaviest cars.

For the vehicles below a weight cap (4,000 pounds in their example), there is no mathematical advantage to adding or reducing weight. As a result automakers have no incentive to make the vehicles near the cap somewhat lighter and therefore safer for the overall fleet. Further, automakers actually have an incentive to increase the weight of the vehicles below the cap thus creating a very large loophole similar to the current light truck loophole. This incentive is not created by the proposed standard, but instead by the existing market forces. Automakers can make larger profits on heavier vehicles today, therefore, there is an inherent financial incentive to increase sales of the heavier vehicles that are more profitable, as we have seen with SUVs. This shift in sales would increase the overall size and weight of the fleet at no penalty to a company's ability to meet the weight based fuel economy standards because the standards drop as the vehicle becomes heavier. Therefore, economic pressures turn the weight neutral slope into an incentive to increase weight, likely producing a fleet of vehicles that all move towards the 4000 lb. mark set in the NAS/NRC example, with an overall reduction in fleet fuel economy. A fleet that minimizes the variations in weight is good for overall safety, however, the cap set in the standard would effectively become an imposed fleet weight. Lower fleet weights could be just as safe, if not safer and would produce larger oil savings. A flat average 40 mpg standard across all car and light truck classes would instead encourage the heaviest vehicles to get lighter and therefore create a fleet that is both safer and more efficient.

The next concern is that, even if we ignore the first issue, the exact fleet fuel economy under this method is quite uncertain. As we have seen with the rise in light truck sales eroding fuel economy, a potential rise in vehicle weights could produce a net drop in fuel economy, even with the example 4000 pound limit. Further, the uncertainties of the political process create the risk for an even higher limit passing, which could further erode fuel economy levels.

Availability of Higher Fuel Economy Vehicles

One assertion made by in the NAS/NRC report that is often put forward by automakers is that, "consumers already have a wide variety of opportunities if they are interested in better gas mileage." (page 1-3) While it is strictly true that there are a number of models on the US market that achieve more than 30 mpg, all of them force the consumer to give up some feature or some amount of performance to obtain the improved fuel economy. They cannot, however, accept in a very few cases, elect to pay more for a vehicle with the same features and performance, but with higher fuel economy. The result is that consumers do not truly have a choice to express a desire for improved fuel economy, all else being equal.

Our analysis and that done by the NAS/NRC panel indicate that the fuel economy of passenger vehicles can be increased while maintaining the size, performance and the various features consumers expect. Our analysis also indicates that consumers can purchase these vehicles without sacrificing and likely increasing overall crash safety. These improvements in fuel economy do come at a cost, but were these vehicles to be offered, consumers would have a true choice of getting all they expect from a car or light truck today, but with higher fuel economy and the associated net savings.

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[i] F. An, D. Friedman, and M. Ross, *Fuel Economy Potential for Light-Duty Trucks*, Society of Automotive Engineers, forthcoming.
[ii] Changes in vehicle price from S. Davis, *Transportation Energy Data Book*, Edition 21, Center for Transportation Analysis, Oak Ridge National Laboratory, September 2001, page 5–14.
[iii] IMPLAN was initially developed by the US Department of Agriculture. Data available from http://www.mig-inc.com/
[iv] D. Friedman, J. Mark, P. Monahan, C. Nash, C. Ditlow, *Drilling in Detroit: Tapping Automaker Ingenuity to Build Safe and Efficient Automobiles*, Union of Concerned Scientists, 2001. AND J. DeCicco, F. An, and M. Ross, *Technical Options for Improving the Fuel Economy of US Cars and Light Trucks by 2010–2015,* American Council for an Energy-Efficient Economy, 2001.
[v] Data Sources: US Department of Labor, Bureau of Labor Statistics, *Employment and Output by Industry, 1990, 2000, and Projected 2010,* 2001; US Department of Commerce, Bureau of Economic Analysis (BEA) Regional Economic Analysis Division, *BEA Regional Projections to 2045: States*, 1995; US Department of Energy, Energy Information Administration, *State Energy Data Report 1999*, May 2001; US Department of Energy, Energy Information Administration, *State Energy Price and Expenditure Report 1999*, November 2001.

[vi] Implementation of the Clean Air Act Amendments of 1970, Part 3: Hearing Before the Subcommittee on Air and Water Pollution of the Senate Committee on Public Works, 92nd Congress, 1st Session (1972), statement of Earnest Starkman, Vice President of General Motors.